DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, PORTLAND DISTRICT
PO BOX 2946
PORTLAND OR 97208-2946

REPLY TO
ATTENTION OF

Planning Programs and Project
Management Division

AUG 1 4 2012

Sean Sheldrake, RPM
USEPA, Region 10
Environmental Cleanup Office
1200 Sixth Avenue, Suite 900, ECL-110
Seattle, WA 98101-3140

Dear Mr. Sheldrake:

Enclosed please find the U.S. Army Corps of Engineers' (USACE) summary of substantial product located at the U.S. Government Moorings (U.S. Moorings) site. Sediment core data collected during the Remedial Investigation and a supplemental investigation were evaluated in accordance with the substantial product criteria specified in the Gasco Sediment Site Statement of Work (SOW). As described in the enclosed technical memorandum, much of the substantial product at depth would be disturbed and/or exposed by maintenance dredging activities or prop wash. All locations that identified areas of substantial product were based on the most current data; however, further investigation may be necessary to define the extent of substantial product at the U.S. Moorings site.

The USACE would also like to point out a couple items identified during this detailed review of the sediment core data. First, location SDOF28 was previously identified as containing substantial product; however, after further evaluation, it was determined that this location did not meet the criteria specified in the SOW. Second, location 20BF was added to the list of cores that meet the criteria for substantial product.

If you have any questions, please contact me at 503-808-4725 or email at christine.m.budai@usace.army.mil. An electronic copy of this letter with enclosure has been provided to Lori Cora (cora.lori@epa.gov), Mark Ader (ader.mark@epa.gov), Jim Anderson (anderson.jim@deq.state.or.us), Dana Bayuk (bayuk.dana@deq.state.or.us), Bob Wyatt (rjw@nwnatural.com), and Patty Dost (pdost@pearllegalgroup.com).

Enclosure

Sincerely,

Christine M. Budai

Christine M. Budai, RPG, PMP
Project Manager

CENWS-EN-GB 27 July 2012

TECHNICAL MEMORANDUM FOR: Chris Budai, Project Manager U.S. Government Moorings

SUBJECT: Summary of Substantial Product in Sediment Cores, U.S. Government Moorings

The purpose of this memorandum is to provide documentation of substantial product found at depth at the U.S. Government Moorings (U.S. Moorings) site. The data provided herein were collected under two previous investigations: The U.S. Moorings Remedial Investigation (RI) in 2008 and a supplemental investigation in 2008/2009.

Definition of Substantial Product

The evaluation of substantial product was completed in accordance with the criteria provided in the Statement of Work (SOW) for the Gasco Sediment site (dated September 9, 2009). The criteria are as follows:

1. *Bands of product, layers of product, "saturated" sediments, "stained" sediments, and/or seams of product that are greater than 2 inches thick.*
2. *Any layer or seam of product, regardless of thickness, that is clearly defined as liquid NAPL that is also mobile (i.e., "oozes" or "drips" out of the core during core observations).*

Modifying factors to this definition are:

3. *If top 5 ft of core has no substantial product under Criteria #1, then deeper product should be judged as "not substantial", even if relatively thick layers of product exist at greater depths.*
4. *If there are any seams of mobile liquid NAPL (not solid or semisolid tar) per Criteria #2 then this is substantial product regardless of depth and the characteristics of overlying sediments.*

The following is NOT substantial product:

- *Any layers of non-mobile product (i.e., bands, layers, saturated sediments, stained sediments) that are less than 2 inches thick.*
- *Petroleum odors that are not associated with visual evidence of product beyond sheens and blebs.*
- *Sheens that are not associated with more substantial visuals of product*
- *Isolated product blebs or spots not associated more substantial visuals of product*

Criteria 3 shall consider whether the 5 feet of overlying relatively clean material includes any sediment that would be expected to be removed as part of Army Corps maintenance dredging in the navigation channel. If so, the 5 ft depth requirement should be judged from the depth to which maintenance dredging would occur.

U.S. Moorings Data

Subsurface sediment core logs and photographs collected during the RI and supplemental investigation were reviewed to determine where the criteria for substantial product were met at the U.S. Moorings site. Lithology descriptions indicative of sediment discoloration (i.e. staining) with associated odors and/or sheen were interpreted as layers containing product. These layers were typically described as "black" or "banded." Only layers greater than 2-inches thick were identified as substantial product, per the SOW criteria. In cases where the "band" thickness was not stated on the core log, core photographs were used to determine which layers met the 2-inch criteria. Core log descriptions that used the term NAPL were interpreted as potential mobile NAPL zones and thus substantial product, regardless of the layer thickness. Note that although core 43BB did not specifically state sediment discoloration, review of the core photograph indicated a discolored zone associated with the location of odor and NAPL blebs described on the logs. Therefore, 43BB was identified as containing substantial product.

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Figure 1 shows the core locations where substantial product was identified. Attachment 1 presents summary core logs highlighting the description that identified the location as containing substantial product. Attachment 2 presents the core photographs with the location of substantial product. For reference, the full core logs from the RI and supplemental investigation are included in Attachment 3.

Additional lines of evidence of sediment contamination are also present at the U.S. Moorings site, such as observations of product less than 2-inches thick and elevated contaminant concentrations in sediment. A detailed analysis of this data is beyond the scope of this memorandum; however, a summary table of chemical characteristics along with sediment core observations indicative of product is presented in Attachment 4 for reference.

U.S. Moorings Dredge Maintenance Requirements

The U.S. Moorings facility needs to accommodate two ocean-going hopper dredges, the Essayons and Yaquina, as part of the navigation mission for the U.S. Army Corps of Engineers. Existing shoaling has reduced the navigational depths substantially, and berth dredging and dock repairs have both been placed on hold because of sediment contamination.

Figure 1 shows future dredge areas (A, B, and C) that may be designed to expose a clean face or to include sufficient over-depth to accommodate a cap. For the purpose of the RI, the dredge depths were defined assuming a 5-foot cap thickness, including armor and barrier/filter. The depths of water in the berths will be -31 feet Columbia River Datum (CRD) for the Essayons and -19 feet CRD for the Yaquina. Assumed dredge depths are:

- Dredge Area A: total dredge depth of -36 feet CRD
- Dredge Area B: total dredge depth of -24 feet CRD
- Dredge Area C: total dredge depth of -24 feet CRD

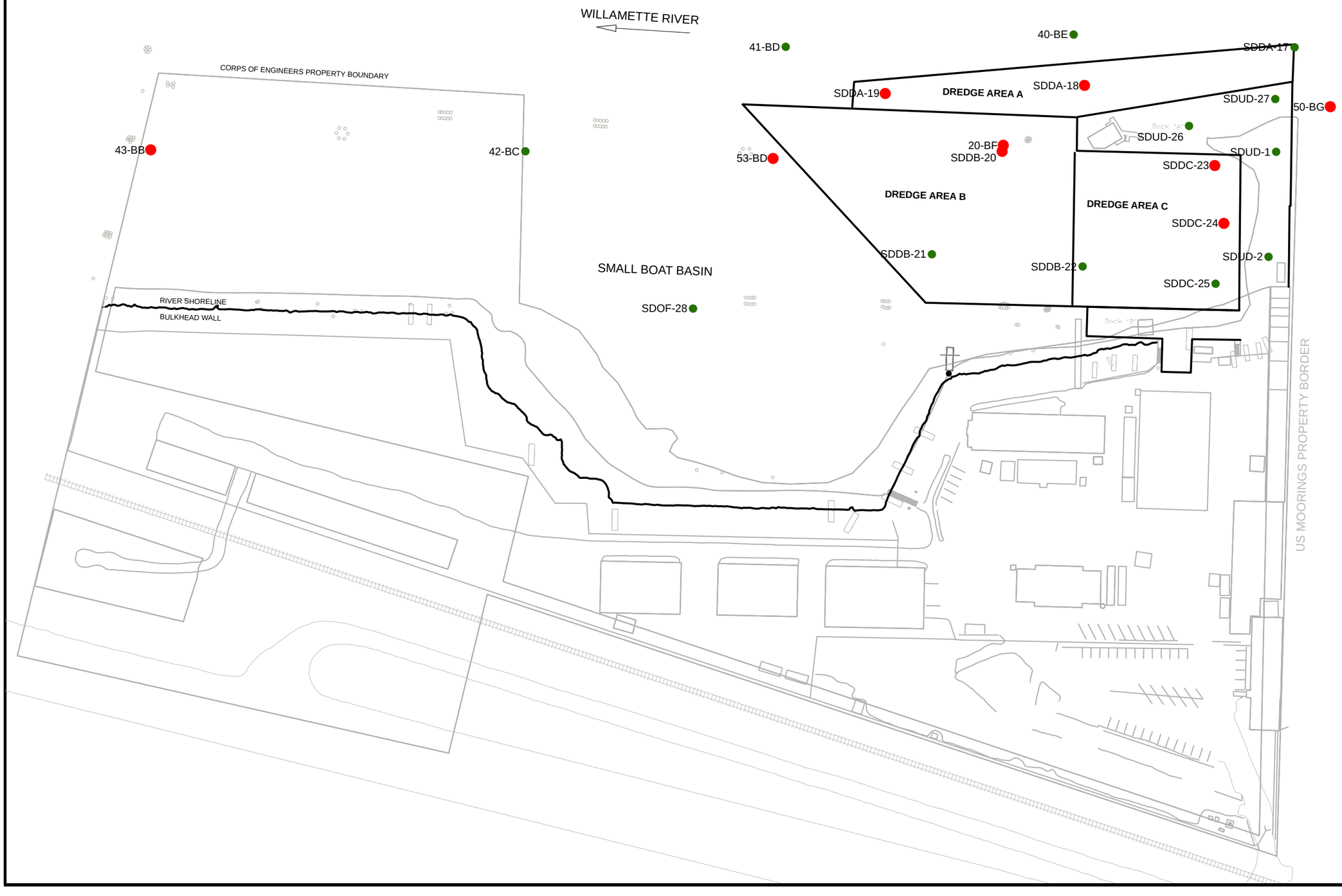
It should be also assumed that the dock area will need to be dredged to a total depth between -24 and -36 feet CRD to remove substantial product, which would require dock removal to prevent reduced structural integrity of the load bearing piles.

The summary core logs show the elevation of substantial product referenced to CRD. Six of the cores with substantial product fall within the designated dredge areas with the assumed dredge depth extending below zones identified as containing substantial product. In these areas, substantial product will be mobilized, if not removed, prior to maintenance dredging. Core 53BD is located just outside the assumed dredge area with substantial product identified below a depth of 5 feet. Since the location of this core has a high potential for scour due to prop wash, substantial product in this areas may also be mobilized.

Attachments:

Attachment 1 – Summary Core Logs
Attachment 2 – Core Photographs
Attachment 3 – Core Logs from the Remedial Investigation and Supplemental Investigation
Attachment 4 – Summary of Bulk Chemical Characteristics in Subsurface Sediment Cores

Enclosure



LEGEND

- Subsurface Sediment Location with Substantial Product
- Subsurface Sediment Sample Location

N

0 50 100 200 Feet

U.S. ARMY CORPS OF ENGINEERS
SEATTLE DISTRICT

FIGURE 1
SUBSURFACE SEDIMENT CORE LOCATIONS

U.S. GOVERNMENT MOORINGS

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Attachment 1

Summary Core Logs

Summary Log Legend


SW - Well-graded sands or gravel-sand mixtures, little to no fines


SM - Silty sands, sand-silt mixture

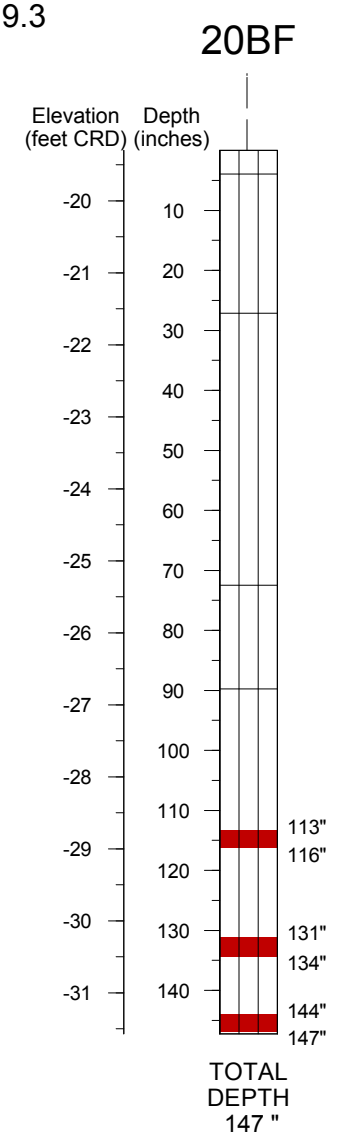

ML - Inorganic silts and very fine sands, silty or clayey find sands or clayey silts with slight plasticity


OL - Organic silts and organic silty clays of low plasticity


Pt - Peat or other highly organic soils

Interval identified as containing substantial product

Project: US Moorings
Location: Portland,Oregon
Date Drilled: 8/25/2009
Mudline Elevation (feet CRD): -19.3
Latitude (deg): 45.58181633
Longitude (deg): 122.7625082



Black, laminar bands at:
(288-295 cm) strong coal tar odor and blue ropy sheen produced with application of water

(333-341 cm) interval is slightly sandy (<10%) and has slight vanillin odor in addition to strong coal tar odor

(366-373 cm) strong coal tar odor and blue ropy sheen produced with application of water

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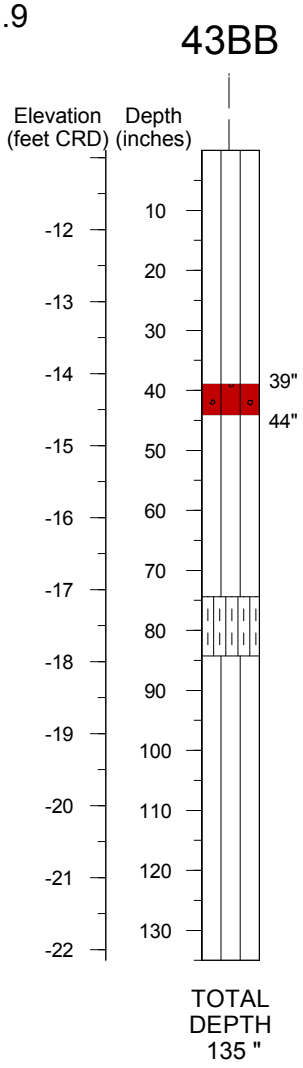
Project: US Moorings
Location: Portland,Oregon
Date Drilled: 8/25/2009
Mudline Elevation (feet CRD): -10.9
Latitude (deg): 45.58329783
Longitude (deg): 122.7651988



(99-112 cm) Stiff, damp to dry, in situ sheen at 110.5 cm, moderate coal tar odor and small (1-2mm) blebs of brown NAPL and ropy sheen can be floated out with application of water.
[Core photo used to determine staining present]

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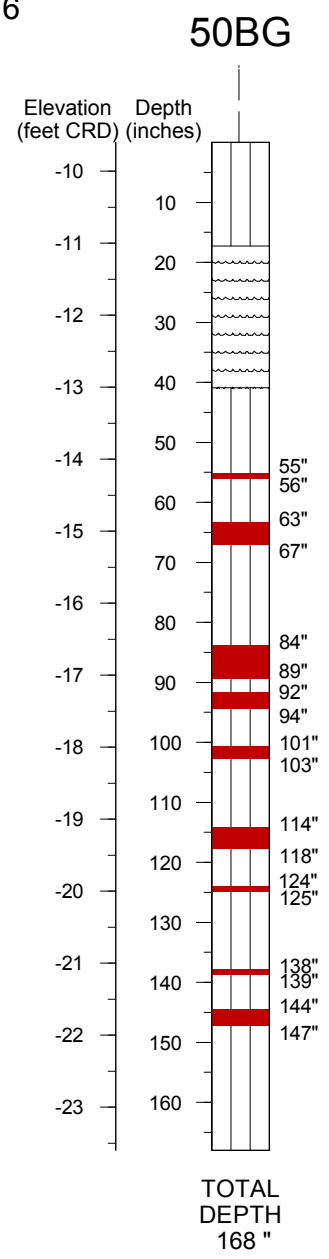
Project: US Moorings
Location: Portland,Oregon
Date Drilled: 8/25/2009
Mudline Elevation (feet CRD): -9.6
Latitude (deg): 45.58133
Longitude (deg): 122.7613838



(140-142.2 cm) Black stained sediment band in laminar orientation. NAPL.
(161-170 cm) Black, woody, strong coal tar odor.

(213-227 cm) Very strong naphthalene odor. NAPL and blue sheen with application of water.
(233-240 cm) Very strong naphthalene odor. NAPL and blue sheen with application of water.

(256-261 cm) In-situ sheen, mineralized NAPL bands, very strong naphthalene odor. NAPL.

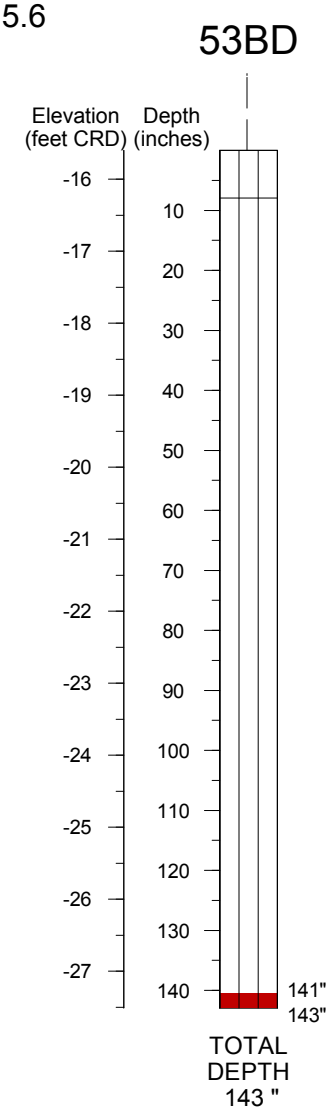
(290-299 cm) Black, dense in-situ sheen. Very strong coal tar odor.

(315-317 cm) Black, strong in-situ sheen and NAPL. Very strong coal tar and naphthalene odor.

(350-352 cm) Black in-situ sheen. NAPL, very strong coal tar odor.
(367-374 cm) Black, in-situ sheen. Strong coal tar odor.

Enclosure

Project: US Moorings
Location: Portland,Oregon
Date Drilled: 8/25/2009
Mudline Elevation (feet CRD): -15.6
Latitude (deg): 45.582191
Longitude (deg): 122.763263



(357 -363 cm) Black stained band of sediment with strong coal tar odor and sheen can be produced in-situ with application of pressure.

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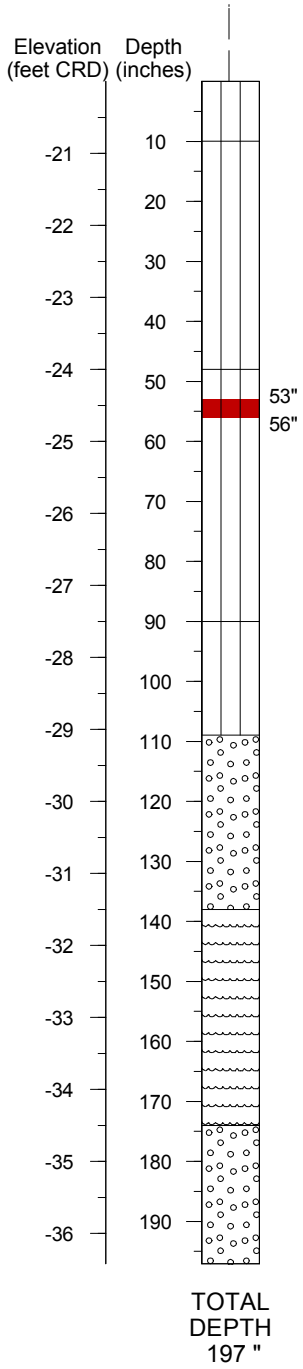
Project: US Moorings
Location: Portland,Oregon
Date Drilled: 4/20/2008
Mudline Elevation (feet CRD): -20
Latitude (deg): 45.58180583
Longitude (deg): 122.7621028

SDDA-18



Bands of black sediment that has strong PAH odor and sheen at 53-56", 63", 64", 75", 77", 81", 92" and 96". [Core photo used to determine bands > 2 inch thick]

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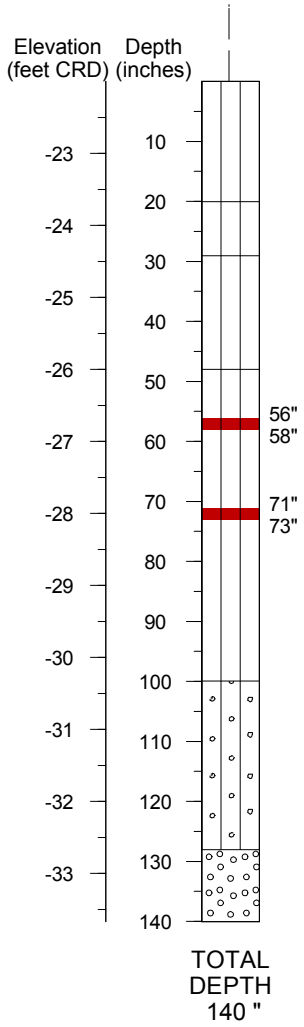
Project: US Moorings
Location: Portland,Oregon
Date Drilled: 4/19/2008
Mudline Elevation (feet CRD): -22
Latitude (deg): 45.58213783
Longitude (deg): 122.7627492

SDDA-19

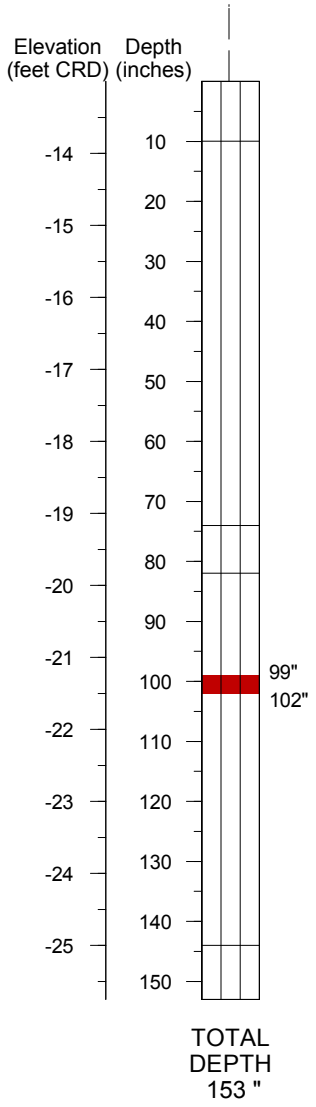


Cohesive, silty clay with occasional thin stringers of very fine sand. Silty clays are banded with black bands with strong coal tar odor and slight sheening. Bands are at 50", 56", 59", 63.5", 67", 71", 76", with mineralized PAH parting planes within the 63.5" and 71" bands.
[Core photo used to determine bands > 2 inch thick]

Enclosure

Project: US Moorings
Location: Portland,Oregon
Date Drilled: 4/19/2008
Mudline Elevation (feet CRD): -13
Latitude (deg): 45.58180583
Longitude (deg): 122.7625263

SDDB-20



Banded, cohesive, silty clay with black bands that have diffuse sheen and strong PAH odor at 99-102", 111", 112", 118", 119", 120", 125", 128", 129-130". Bands are thin (<0.5") unless noted as a range.

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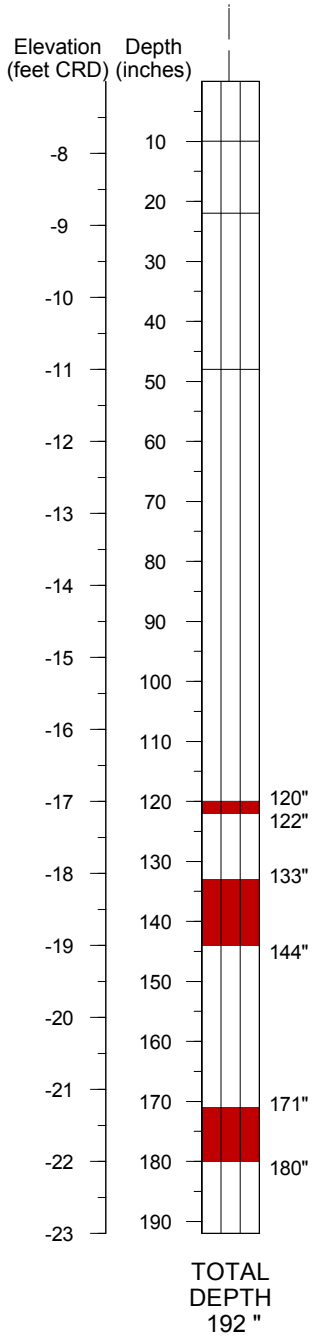
Project: US Moorings
Location: Portland,Oregon
Date Drilled: 4/20/2008
Mudline Elevation (feet CRD): -7
Latitude (deg): 45.58140267
Longitude (deg): 122.761893

SDDC-23



120-144". Banded black and brown silty clay with laminar lenses of wood particles. Very strong PAH/coal tar odor. No free NAPL but widespread irredescent sheen in 0.1-0.25 florets.
[Core photo used to determine bands > 2 inch thick]

171-180" thick band of black, PAH enriched sediment with strong odor.

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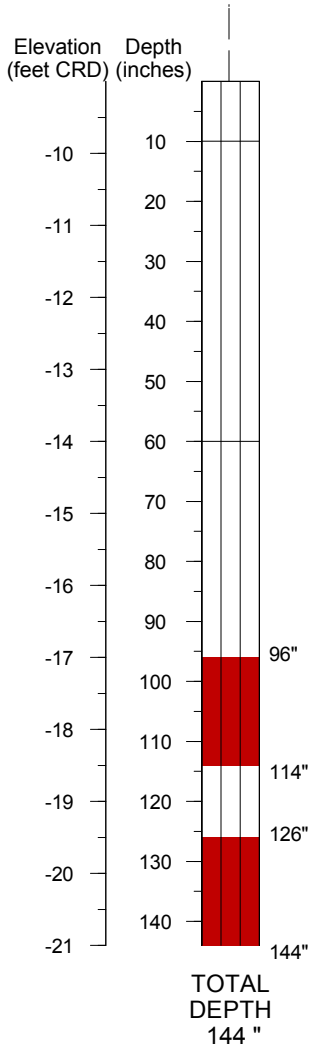
Project: US Moorings
Location: Portland,Oregon
Date Drilled: 4/19/2008
Mudline Elevation (feet CRD): -9
Latitude (deg): 45.5812595
Longitude (deg): 122.7620083

SDDC-24



96-114". Loose, wet, black, woody silt with H2S and coal tar odors. Strong. Sheen in abundant 0.2" florets.

126-144". Laminated, black, organic silty clay with wood fragments, sheen and strong PAH odor. Several laminar bands have mineralized PAH parting planes.

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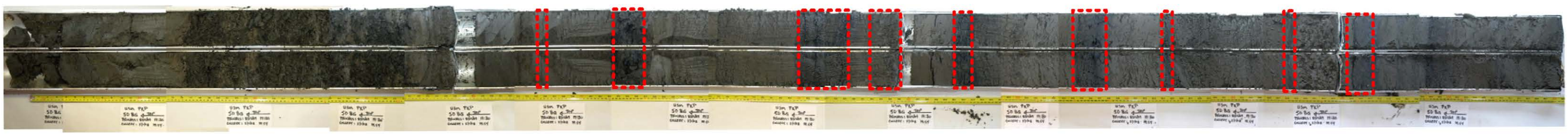
Attachment 2

Core Photographs

20BF

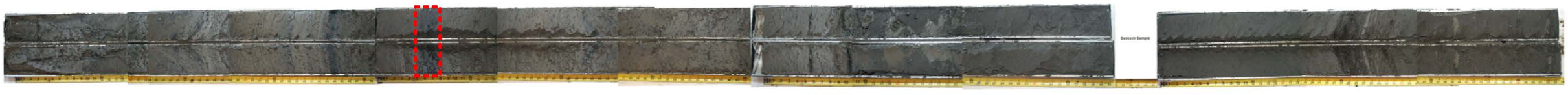
43BB

50BG



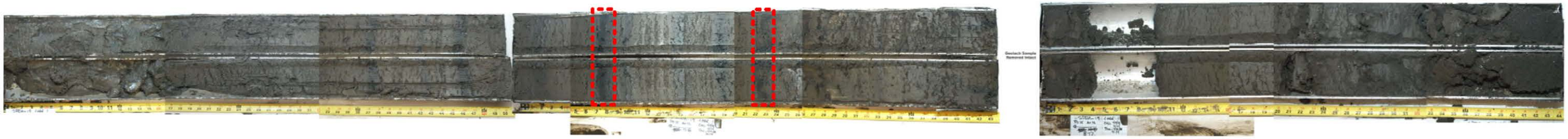
53BD

SDDA-18



Zone identified as containing substantial product

SDDA-19



SDDB-20

SDDC-23

SDDC-24

Zone identified as containing substantial product

Attachment 3

Core Logs from the Remedial Investigation and Supplemental Investigation

Major Divisions		Symbols	Typical Names
Coarse Grained Soils (More than 1/2 of soil >No. 200 sieve size)	Gravels (More than 50% coarse fraction > no. 4 sieve	GW	Well-graded gravels or gravel-sand mixtures, little to no fines
		GP	Poorly-graded gravels or gravel-sand mixtures, little to no fines
		GM	Silty gravels, gravel-sand-silt mixtures
		GC	Clayey gravels or gravel-sand-clay mixtures
	Sands (Less than 50% coars fraction > no. 4 sieve)	SW	Well-graded sands or gravel-sand mixtures, little to no fines
		SP	poorly-graded sands or gravelly sands, little to no fines
		SM	Silty sands, sand-silt mixtures
		SC	Clayey sands, sand-clay mixtures
Fine Grained Soils (More than 1/2 of soil <No. 200 sieve size)	Silts & Clays Liquid limit* less than 50%	ML	Inorganic silts and very fine sands, silty or clayey fine sands or clayey silts with slight plasticity
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy or silty clays, lean clays
		OL	Organic silts and organic silty clays of low plasticity
	Silts & Clays Liquid limit* greater than 50%	MH	Inorganic silts, micaceous or ditomaceous fine sand or silty soils, elastic silts
		CH	Inorganic clays of high plasticity, fat clays
		OH	Organic clays of medium to high plasticity, organic silty clay, organic silts
Highly Organic Soils		Pt	Peat or other highly organic soils

*Liquid limit represents the moisture contnet (in percent) of a soil at which point the soil no longer behaves like a plastic and starts to behave like a liquid.

Boring Log Symbols

Sample Interval

Groundwater, First Observed

Groundwater, Static

Sample Types

SS	Split Spoon
G	Grab
ST	Shelby Tube
GS	Geoprobe Sampler

Sheen Types

NS	No Sheen Observed
SS	Slight Sheen observed (Spotty coverage of sheen pan, no
MS	Moderate Sheen (Full Coverage)
HS	Heavy Sheen (Full Coverage, Irredescent)

Sample Moisture

Dry	No Moisture, dry to touch
Moist	Damp but no visible moisture
Wet	Visible free water

Sample Plasticity (Fine-Grained Soils)

Non-Plastic - Cannot be rolled at any moisture content

Low - Barely rolled, lump cannot be formed when drier than plastic limit

Medium - Easily rolled, lump crumbles when drier than plastic limit

High - Easily rolled yet takes considerable time to reach the plastic limit, lump can be formed without crumbling when drier than the plastic limit

Partical Size Range (Course-Grained Soils)

Gravel - Fine, Coarse

Sand - Fine, Medium, Coarse

Based on Unified Soil Classification System and ASTM Standard D2487 and D2488

Core Location F

BORING NUMBER	20 BF
PROJECT	US Moorings PRP Study
LOCATION	Willamette River, Portland, OR
PROJECT NUMBER	
DATE	25-Aug-09
LOGGED BY	D. Browning

SAMPLE INFORMATION						STRATA	DESCRIPTION
Sample ID	Interval Top (cm)	Interval Bottom (cm)	% Recov.	Sheen	Depth (cm)		USCS group name, color, grain size range, minor constituents, plasticity, odor, sheen, moisture content, texture, weathering, cementation, geologic interpretation, etc.
F-SS20-BF-0	0	5		N			**0-10 cm. 7.5YR 3/2. Slightly soft, silty (30%) clay (70%).**
				N	20		Acrid decomposing organics odor.
				N			**10-69 cm. 2.5Y 3/2. Slightly soft, moist, organic (<5%), silty (20-30%) clay (70-80%).**
				N			Cohesive, plastic and slight acrid decomposing organics odor. No sheen visible with
				N	40		application of water. Homogeneous.
				N			
F-SS20-BF-24	58	63		N	60		**69-184 cm. 2.5Y 3/2. Soft, moist, organic (<5%), very clayey (40-50%) silt (50-60%)**
				N			with trace (<1%) very fine sand. Slight organic odor. No sheen could be produced with
				N	80		application of water.
				N			
				N	100		
				N			
				N	120		
				N			
				N	140		
				N			
				N	160		
F-SS20-BF-66	165	170		N			
				N	180		
				N			**184-228 cm. 2.5Y 3/2. Slightly firm, consolidated, moist, organic (<5%), very clayey**
				N	200		**(40-50%) silt (50-60%)** with trace (<1%) very fine sand.
				N			Slight coal tar odor. No sheen could be produced with application of water.
				N	240		**228-374 cm. 2.5Y 3/2. Slightly soft, plastic, moist to damp, organic (<1%)**
				MS			**silty (15-20%) clay (80-85%).**
				MS	260		Slight coal tar odor in upper portion of unit. Black, laminar bands at:
				MS			225-228 cm with moderate to strong coal tar odor
				MS	280		244-245 cm with strong coal tar odor
				MS			267-269 cm strong coal tar odor and blue ropy sheen produced with application of water.
F-SS20-BF-116	292	297		MS	300		288-295 cm strong coal tar odor and blue ropy sheen produced with application of water.
				MS			315-315.5 cm strong coal tar odor and blue ropy sheen produced with application of water.
				MS	320		319-320 cm strong coal tar odor and blue ropy sheen produced with application of water.
				MS			

Coring Contractor	Marine Sampling Systems/RV Nancy Ann
Coring Method	Vibracore
Core Type	4" OD; 3.75"ID pre-cleaned 6061 Aluminum
Core Collected	
COORDINATES	
SURFACE ELEVATION	
DATUM	

Notes:
Penetration: 13 feet
Acquisition: 13 feet
Recovery: 100%

Cores archived frozen since collection and thawed prior to Processing
Core not expanded based on compaction during processing

BORING NUMBER	20 BF
PROJECT	US Moorings PRP Study
LOCATION	Willamette River, Portland, OR
PROJECT NUMBER	
DATE	25-Aug-09
LOGGED BY	D. Browning

SAMPLE INFORMATION						STRATA	DESCRIPTION
Sample ID	Interval Top (cm)	Interval Bottom (cm)	% Recov.	Sheen	Depth (cm)		USCS group name, color, grain size range, minor constituents, plasticity, odor, sheen, moisture content, texture, weathering, cementation, geologic interpretation, etc.
				MS			In black layers, sheen can also be produced in situ with application of pressure on sediment.
				MS			
F-SS20-BF-146	344	349		MS	340		333-341 cm interval is slightly sandy (<10%) and has slight vanillin odor in addition to strong
				MS			coal tar odor.
				MS	360		366-373 cm strong coal tar odor and blue ropy sheen produced with application of water.
				MS			
					374		**374 cm EOC**

		Notes:
Coring Contractor	Marine Sampling Systems/RV Nancy Ann	Penetration: 13 feet
Coring Method	Vibracore	Acquisition: 13 feet
Core Type	4" OD; 3.75"ID pre-cleaned 6061 Aluminum	Recovery: 100%
Core Collected		
COORDINATES		Cores archived frozen since collection and thawed prior to
SURFACE ELEVATION		Processing
DATUM		Core not expanded based on compaction during processing

Core Location B

BORING NUMBER	43BB
PROJECT	U.S. Moorings
LOCATION	Willamette River, Portland, OR
PROJECT NUMBER	
DATE	25-Aug-09
LOGGED BY	D. Browning

SAMPLE INFORMATION						STRATA	DESCRIPTION
Sample ID	Interval Top (cm)	Interval Bottom (cm)	% Recov.	Sheen	Depth (cm)		USCS group name, color, grain size range, minor constituents, plasticity, odor, sheen, moisture content, texture, weathering, cementation, geologic interpretation, etc.
B-43-BB-0	0	5		N			**0-99 cm. 2.5 3/1. very silty (40-50%) clay (50-60%)**
				N	20		Soft, moist, organic, plastic, with scattered organic/plant fragments throughout.
				N			Homogeneous. Slight natural organic odor. No sheen could be produced with
				N	40		application of water.
				N			
B-43-BB-24	58	63		N			
				N	60		
				N			
				N	80		
				N			
				N	100		
B-43-BB-40	99	104		SS			**99-112 cm. 2.5Y 3/2. Slightly silty (10-15%) fine sand (85-90%) trace organics (<5%).**
				SS	120		Stiff, damp to dry, in situ sheen at 110.5 cm, moderate coal tar odor ad small (1-2mm) blebs of
				MS			brown NAPL and ropy sheen can be floated out with application of water.
				MS	140		**112-189 cm. 2.5Y 3/1. silty (30-40%) clay (60-70%) with trace (<5%) organics**
				MS			Soft, moist, plastic, with preserved methane vesicles. 1-2 mm lenses of organic particles at
				MS	160		131 and 137 cm. Slight coal tar odor and natural organic odor. 170-179 cm florets of sheen
				MS			can be produced by streaking sediment and sheen can prodiced from this usit with application
				SS	180		of water.
				MS			
				SS	200		**189-214 cm. 2.5Y 3/1. organic (>20% wood), fine sandy (20-30%), silt (50-60%).**
B-43-BB-78	196	201		SS			Soft, moist to wet, wood present as fragments, strong coal tar odor and 1-3 cm streak
				N	220		of in situ dull sheen.
				N			**214-343 cm. Gley 1 10Y 2.5/1. Fine sandy (10-20%) clayey (30-40%) silt (50-60%)**
				N	240		Soft to slightly firm, damp, intercollated sand present as discrete laminar stringers/lenses.
				N			Stringers/lenses of sand at 214-248 cm, 301-302 cm, 309-325 cm. Slight decaying
				N	260		organics odor. No sheen produced with application of water.
				N			
				N	280		
				N			
B-43-BB-116	292	297		N	300		
				N			

Coring Contractor	Marine Sampling Systems/RV Nancy Ann
Coring Method	Vibracore
Core Type	4" OD; 3.75"ID pre-cleaned 6061 Aluminum
Core Collected	
COORDINATES	
SURFACE ELEVATION	
DATUM	

Notes:
Penetration: 13 feet
Acquisition: 11.5 feet
Recovery: 88.5%

Cores archived frozen since collection and thawed prior to Processing
Core not expanded based on compaction during processing

BORING NUMBER	43BB (continued)
PROJECT	U.S. Moorings
LOCATION	Willamette River, Portland, OR
PROJECT NUMBER	
DATE	25-Aug-09
LOGGED BY	D. Browning

SAMPLE INFORMATION							DESCRIPTION
Sample ID	Interval Top (cm)	Interval Bottom (cm)	% Recov.	Sheen	Depth (cm)	STRATA	USCS group name, color, grain size range, minor constituents, plasticity, odor, sheen, moisture content, texture, weathering, cementation, geologic interpretation, etc.
				N			**214-343 cm. Gley 1 10Y 2.5/1. Fine sandy (10-20%) clayey (30-40%) silt (50-60%)**
				N	320		
				N			
				N	340		
				N			**343 cm EOC**
					360		

Coring Contractor	Marine Sampling Systems/RV Nancy Ann
Coring Method	Vibracore
Core Type	4" OD; 3.75"ID pre-cleaned 6061 Aluminum
Core Collected	
COORDINATES	
SURFACE ELEVATION	
DATUM	

Notes:
Penetration: 13 feet
Acquisition: 11.5 feet
Recovery: 88.5%

Cores archived frozen since collection and thawed prior to Processing
Core not expanded based on compaction during processing

Core Location G

BORING NUMBER	50BG
PROJECT	U.S. Moorings
LOCATION	Willamette River, Portland, OR
PROJECT NUMBER	
DATE	25-Aug-09
LOGGED BY	D. Browning

SAMPLE INFORMATION						STRATA	DESCRIPTION
Sample ID	Interval Top (cm)	Interval Bottom (cm)	% Recov.	Sheen	Depth (cm)		USCS group name, color, grain size range, minor constituents, plasticity, odor, sheen, moisture content, texture, weathering, cementation, geologic interpretation, etc.
G-5--BG-0	0	5		N			**0-44 cm. 2.5Y 4/2. Slightly silty (15-20%) clay (80-85%).**
				N			Stiff, dry to slightly damp. 10-12 cm band of small (<0.5 cm) organic fragments
				N	20		(root/plant particles). Natural organic odor. No sheen produced with application of water.
				N			
				MS	40		**44-104 cm. Gley 1 2.5/N. Very clayey (40-50%) wood (50-60%).**
				MS			Black, soft, moist. Wood particles are mechanically fragmented and many have a blue coating
G-50-BG-26	66	71		MS	60		that becomes more pronounced with increased time exposed to air. Strong tar odor.
				MS			Minor sheen produced with application of water.
				MS	80		
				MS			
				MS	100		
				MS			**104-427 cm. 2.5Y 2.5/1. Slightly silty (20%) clay (80%).**
				MS			Trace fine sand (<1%). Enitire unit is sompositionally similar in terms of sediment type.
				MS	120		Numerous depositional bands in unit.
				MS			136-136.5 cm. Band of wood/plant fragments with coal tar odor.
				HS	140		140-142.2 cm. Black stained sediment band in laminar orientation. NAPL.
				HS			
				HS	160		161-170 cm, Black, woody, strong coal tar odor.
				HS			
G-50-BG-72	182	188		HS	180		
				HS			191-192. Black stained sediment and mineralized NAPL plane. Very strong coal tar odor.
				HS	200		
				HS			213-227 cm. Black, organic, in-situ sheen and strong coal tar and naphthalene odors.
				HS	220		
				HS			233-240 cm. Very strong naphthalene odor. NAPL and blue sheen with application of water.
				HS	240		240-245 cm. Air pocket/void.
G-50-BG-98	249	254		HS			245-256 cm. Strong to overwhelming naphthalene odor. In-situ sheen with pressure.
				HS	260		256-261 cm. In-situ sheen, mineralized NAPL bands, very strong naphthalene odor. NAPL.
				HS			261-290 cm. 2.5Y 3/2. Moist. Very strong coal tar and naphthalene odor.
				HS	280		
G-50-BG-116	295	300		HS			290-299 cm. Black, dense in situ sheen. Very strong coal tar odor.
				HS	300		299-315 cm. 2.5Y 3/2. Moist. Very strong coal tar and naphthalene odor.

Coring Contractor	Marine Sampling Systems/RV Nancy Ann	Notes:
Coring Method	Vibracore	Penetration:
Core Type	4" OD; 3.75"ID pre-cleaned 6061 Aluminum	Acquisition:
Core Collected	19-April-2008	Recovery:
COORDINATES		Cores archived frozen since collection and thawed prior to
SURFACE ELEVATION		Processing
DATUM		Core not expanded based on compaction during processing

BORING NUMBER	50 BG
PROJECT	U.S. Moorings
LOCATION	Willamette River, Portland, OR
PROJECT NUMBER	
DATE	25-Aug-09
LOGGED BY	D. Browning

SAMPLE INFORMATION						STRATA	DESCRIPTION
Sample ID	Interval Top (cm)	Interval Bottom (cm)	% Recov.	Sheen	Depth (cm)		USCS group name, color, grain size range, minor constituents, plasticity, odor, sheen, moisture content, texture, weathering, cementation, geologic interpretation, etc.
				HS			
				HS	320		315-317 cm. Black, strong in situ sheen and NAPL. Very strong coal tar and naphthalene odor.
				HS			317-350 cm. 2.5Y 3/2. Silty (20%) clay (80%) with strong coal tar odor.
				HS	340		slightly soft, plastic.
				HS			
				HS	360		350-352 cm. Black, in-situ sheen, NAPL, very strong coal tar odor.
				HS			352-367 cm. In-situ sheen and very strong coal tar odor.
G-50-BG-146	370	376		HS	380		367-374 cm. Black, in situ sheen. Strong coal tar odor.
				HS			380 cm. Plane of mineralized NAPL.
				MS	400		390-391 cm. Laminar black band with in-situ sheen and very strong coal tar odor.
				MS			391-427 cm. Slightly soft, plastic, damp to moist silty (15-20%) clay (80-85%). Moderate
				MS	420		coal tar odor.
							427 cm EOC
					440		

Coring Contractor	Marine Sampling Systems/RV Nancy Ann	Notes:
Coring Method	Vibracore	Penetration:
Core Type	4" OD; 3.75"ID pre-cleaned 6061 Aluminum	Acquisition:
Core Collected		Recovery:
COORDINATES		
SURFACE ELEVATION		Cores archived frozen since collection and thawed prior to Processing
DATUM		Core not expanded based on compaction during processing

Core Location D2

BORING NUMBER	53BD
PROJECT	U.S. Moorings
LOCATION	Willamette River, Portland, OR
PROJECT NUMBER	
DATE	25-Aug-09
LOGGED BY	D. Browning

SAMPLE INFORMATION						STRATA	DESCRIPTION
Sample ID	Interval Top (cm)	Interval Bottom (cm)	% Recov.	Sheen	Depth (cm)		USCS group name, color, grain size range, minor constituents, plasticity, odor, sheen, moisture content, texture, weathering, cementation, geologic interpretation, etc.
D2-53-BD-0	0	5		N			**0-20 cm. 2.5Y 3/3. Silty (40%) clay (60%).**
				N			Dry, soft, natural organic odor. Texture has been modified by freezing/thaw.
				N	20		**20-363 cm. 5Y 2.5/1. Trace sandy (<5%), silty (30-40%) clay (55-70%).**
				N			Bulk unit, soft, cohesive, slightly plastic. Moist. Multiple substrata
				N	40		
D2-53-BD-24	61	66		N			58 cm. Vesiculated slag with PAH odor. No sheen produced with application of water.
				N	60		
				N			71 cm. Coal tar odor, no sheen produced with application of water.
				N	80		
				N			
				Y	100		
				Y			
				N	120		125 cm. 1 mm stringer of sand, coal tar odor.
				N			
				N	140		
				N			
				N	160		
				N			
				N	180		
				N			183 cm. Laminar stringer/parting plane of very fine sand.
				N			195-199 cm. Silty (30%) fine sand (70%) with distinct coal tar odor.
D2-53-BD-83	211	216		SS	200		205-212 cm. Loose, wet layr of wood and plant particles. Strong coal tar odor. Sheen can
				N			be produced as ribbons with application of water.
				N	220		
				N			
				N	240		
				N			
				N	260		
				N			
				N	280		
				N			
				SS	300		295 cm. Laminar band of black sediment with stron coal tar odor. Sheen produced with
D2-53-BD-118	300	305		SS			application of water.

Coring Contractor	Marine Sampling Systems/RV Nancy Ann
Coring Method	Vibracore
Core Type	4" OD; 3.75"ID pre-cleaned 6061 Aluminum
Core Collected	
COORDINATES	
SURFACE ELEVATION	
DATUM	

Notes:
Penetration:
Acquisition:
Recovery:

Cores archived frozen since collection and thawed prior to Processing

Core not expanded based on compaction during processing

BORING NUMBER	53BD
PROJECT	U.S. Moorings
LOCATION	Willamette River, Portland, OR
PROJECT NUMBER	
DATE	25-Aug-09
LOGGED BY	D. Browning

SAMPLE INFORMATION							DESCRIPTION
Sample ID	Interval Top (cm)	Interval Bottom (cm)	% Recov.	Sheen	Depth (cm)	STRATA	USCS group name, color, grain size range, minor constituents, plasticity, odor, sheen, moisture content, texture, weathering, cementation, geologic interpretation, etc.
				N			**20-363 cm. 5Y 2.5/1. Trace sandy (<5%), silty (30-40%) clay (55-70%).**
				N	320		
				N			
				N	340		
				N			357-363 cm. Black stained band of sediment with strong coal tar odor and sheen can
D2-53-BD-143	363	368		HS	360		be produced in-situ with application of pressure.
							363 cm EOC
					380		

Coring Contractor	Marine Sampling Systems/RV Nancy Ann	Notes: Penetration:
Coring Method	Vibracore	Acquisition:
Core Type	4" OD; 3.75"ID pre-cleaned 6061 Aluminum	Recovery:
Core Collected		
COORDINATES		Cores archived frozen since collection and thawed prior to
SURFACE ELEVATION		Processing
DATUM		Core not expanded based on compaction during processing

BORING NUMBER	SDDA-18 Core 1
PROJECT	U.S. Moorings
LOCATION	Willamette River, Portland, OR
PROJECT NUMBER	
DATE	22-Apr-08
LOGGED BY	D. Browning

SAMPLE INFORMATION						STRATA	DESCRIPTION
Sample ID	Time		% Recov.	Sheen	Depth (inches)		USCS group name, color, grain size range, minor constituents, plasticity, odor, sheen, moisture content, texture, weathering, cementation, geologic interpretation, etc.
				N			**0-10" SILTY CLAY (ML)**
				N	12		Wet, unconsolidated silty clay (30/70) with scattered very minor fine sand. Petroleum odor.
				SS			**10-10.75"**
				SS	24		Black band of poorly graded sandy silt (40/60) with strong petroleum odor and sheen.
				SS			Mineralized parting plane
				SS	36		**10.75-48" SILTY CLAY (ML)**
				SS			Soft, brownish olive-gray, methanogenic, mosit silty/clay (30/70) with thin (<1") sand stringers.
				SS	48		Bands of black sediment throughout unit and banded sediment has stong PAH oder. Bands
				SS			are 0.1-0.2 " thick and are at 24",26",30",31",38",41",43",44" below mudline.
				SS	60		**48-90" SILTY CLAY (ML)**
				SS			Soft, slightly cohesive silty clay that is moist and methanogenic. Varies from brown to black.
				SS	72		Interbedded stringers of silt and sorted very fine sand 58-59", 61.5", 71", 76" and 82".
				SS			Stringers are 0.25" thick at maximum. Bands of black sediment that has strong PAH odor and
				SS	84		sheen at 53-56", 63", 64", 75", 77",81"92" and 96". Mineralized PAH parting plane in 63" band.
				SS			
				SS	96		
				SS			**96-109" SILTY CLAY (ML)**
				SS	108		Soft, moist, cohesive, plastic, silty clay (30/70) with black band having mineralized PAH parting
				N			planes at 102" and 107".
				N	120		**109-138" SAND (SW)**
				N			Soft, damp, well-sorted, uniformly graded, gray fine sand with clasts of silty clay.
				N	132		No odor, no sheen.
				N			
					144		**138-144"- Not logged. Retained intact for geotech sample.**
				N			**144-167" SAND (SW)**
				N	156		Soft, damp, well-sorted, uniformly graded, gray fine sand with clasts of silty clay.
				N			No odor, no sheen.
				N	168		**167-174 Peat (Pt)**
				N			Peaty, oganic silt with laminar wood, root and plant fragments. Compact, wet.
				N	180		**174-197" SAND (SW)**
				N			Firm, well-sorted, uniformly graded fine sand with rip-up clasts of cohesive brown clay.

Coring Contractor	Marine Sampling Systems/RV Nancy Ann
Coring Method	Vibracore
Core Type	4" OD; 3.75"ID pre-cleaned 6061 Aluminum
Core Collected	20-April-2008
COORDINATES	
SURFACE ELEVATION	
DATUM	

Notes:
Penetration: 19 ft
Acquisition: 16.8 ft
Recovery: 88%

Core not expanded based on compaction during processing
Material in core catcher discarded.

BORING NUMBER	SDDA-19 Core 1
PROJECT	U.S. Moorings
LOCATION	Willamette River, Portland, OR
PROJECT NUMBER	
DATE	22-Apr-08
LOGGED BY	D. Browning

SAMPLE INFORMATION						STRATA	DESCRIPTION
Sample ID	Time		% Recov.	Sheen	Depth (inches)		USCS group name, color, grain size range, minor constituents, plasticity, odor, sheen, moisture content, texture, weathering, cementation, geologic interpretation, etc.
				N			**0-20" SILTY CLAY (ML)**
				N	12		Unconsolidated. Wet, homogeneous, very silghtly sandy, clayey silt (5/30-35/60-70)
				N			becoming slightly more consolidated with depth.
				N	24		**20-29" SILTY CLAY (ML)**
				N			Soft, wet, highly organic, silty clay with >20% wood by volume and PAH odor.
				N	36		**20-48" SILTY CLAY (ML)**
				N			Intercollated, slightly fine sandy silt and clay. 0.5 to 0.75 bands of black clay with moderate to
				N	48		strong PAH odor at 38", 42: and 46". Stringer of fine sand at 48".
				SS			**48-100" SILTY CLAY (ML)**
				SS	60		Cohesive, silty clay (30/70) with occasional thin stringers of very fine sand. Silty clays are
				SS			banded with black bands with strong coal tar ofor and slight sheening. Bands are at
				SS	72		50", 56", 59", 63.5 ", 67",71", 76", with mineralized PAH parting planes within the 63.5" and
				SS			71" bands. Three hard, 0.25 " dia. cohesive clay clasts at 78". Number of fine sand
				SS	84		stringers increases between 84-90"
				SS			
					96		90-96" Not logged. Retained intact for geotech sample.
							100-128" SAND (SM)
					108		Firm, moist, dark brown, silty fine sand (30/70) with very minor clay subcomponen that is
							present in intercollated lenses. No odor, no sheen.
					120		**128-140 SAND (SW)**
							Firm, damp, well-sorted, uniformaly graded, very fine sand. No odor, no sheen.
					132		
							EOC
					144		
					156		
					168		
					180		

Coring Contractor	Marine Sampling Systems/RV Nancy Ann
Coring Method	Vibracore
Core Type	4" OD; 3.75"ID pre-cleaned 6061 Aluminum
Core Collected	19-April-2008
COORDINATES	
SURFACE ELEVATION	
DATUM	

Notes:
Penetration: 15 ft
Acquisition: 12 ft
Recovery: 80%

Core expanded based on compaction during processing
Material in core catcher discarded.

Enclosure

BORING NUMBER	SDDB-20
PROJECT	U.S. Moorings
LOCATION	Willamette River, Portland, OR
PROJECT NUMBER	
DATE	22-Apr-08
LOGGED BY	D. Browning

SAMPLE INFORMATION						STRATA	DESCRIPTION
Sample ID	Time		% Recov.	Sheen	Depth (inches)		USCS group name, color, grain size range, minor constituents, plasticity, odor, sheen, moisture content, texture, weathering, cementation, geologic interpretation, etc.
				N			**0-10" SILTY CLAY (ML)**
				N			Loose, wet, olive-brown silty clay. Unconsolidated and almost fluid. Methane vesicles and no
				N	12		odor.
				N			
				N	24		
				N			
				N			**10-74" SILTY CLAY (ML)**
				N	36		Very soft, olive brown, silty clay (30/70) with methane vesicles and small organic/plant
				N			fragments scattered throughout. Slightly plastic in upper portion and grades to plastic at
				N	48		**46"-74".SILTY CLAY (ML)**
				N			
				N	60		
				N			
				N			**74-82" SILTY CLAY (ML)**
				N	72		Black to brown, soft, cohesive, pastic, silty clay with PAH odor. Black band at 74"-75".
				SS			
				SS	84		
							90-96" Not logged. Retained intact for geotech sample.
					96		
				SS			**82"-144" SILTY CLAY (ML)**
				SS	108		Banded, cohesive, silty clay with black bands that have diffuse sheen and stron PAH odor at
				SS			99-102", 11", 112", 118", 119", 120", 125", 128", 129-130". Bands are thin (<0.5") unless
				SS	120		noted as a range.
				SS			
					132		**133-140" Gap in sample**
				N			**140-153" SILTY CLAY (ML)**
				N	144		Cohesive, interbedded, fine sandy silt and clay.
					156		**EOC**
					168		
					180		

Coring Contractor	Marine Sampling Systems/RV Nancy Ann
Coring Method	Vibracore
Core Type	4" OD; 3.75"ID pre-cleaned 6061 Aluminum
Core Collected	19-April-2008 13:30
COORDINATES	
SURFACE ELEVATION	
DATUM	

Notes:
Penetration: 13 ft
Acquisition: 13 ft
Recovery: 100%

Core not expanded based on compaction during processing
Material in core catcher discarded.

BORING NUMBER	SDDC-23
PROJECT	U.S. Moorings
LOCATION	Willamette River, Portland, OR
PROJECT NUMBER	
DATE	23-Apr-08
LOGGED BY	D. Browning

SAMPLE INFORMATION						STRATA	DESCRIPTION
Sample ID	Time	No. of Jars	% Recov.	Sheen	Depth (inches)		USCS group name, color, grain size range, minor constituents, plasticity, odor, sheen, moisture content, texture, weathering, cementation, geologic interpretation, etc.
				N			**0-10" SILTY CLAY (ML)**
				N			Loose, wet, unconsolidated, slightly silty clay (20/80).. No odor.. Wood and plant fragments.
				N	12		**10"-22" SILTY CLAY (ML)**
				N			Soft, wet, silt with methane vesicles and slight PAH odor.
				N	24		**22-48" SILTY CLAY (ML)**
				N			Soft, organic silt with methane vesicles and scattered small (<0.5") plant fragments.
				N	36		Black bands at 30-32" that have no odor.
				N			
				N	48		**48-120" SILTY CLAY (ML)**
				N			Soft, slightly plastic, organic silty clay (30/70) with methane vesicles and homogenous
				N	60		texture. Occasional thin (<0.25") laminar bands of oprganics (plant fragments)
				N			
				Y	72		72-84" Black organic inclusion that contain wood fragments and have PAH odor.
				N			
				N	84		
				N			
				N	96		100" cored through wood fragment
				N			
				Y	108		
				Y			108-120 Sediment becomes darker, sheening occurs and strong PAH odor.
				Y	120		**120-144" SILTY CLAY (ML)**
				Y			Banded black and brown silty clay (30/70) with laminar lenses of wood particles. Very strong
				Y	132		PAH/coal tar odor. No free NAPL but widespread irresescent sheen in 0.1-0.25 florets.
					144		
				Y			**144-150 Retained intact for geotech sample**
				Y			**150-180" SILTY CLAY (ML)**
				Y	156		Firm, moist, plastic, organic silty clay (30/70) with laminar black bands at 153-156",
				Y			162", 163". Each band 0.2" thick and has strong sheening and strong to overwheming
				Y	168		PAH/Coal tar odor. 171-180" thick band of black, PAH enriched sediment with strong odor.
				Y			**180-192" SILTY CLAY (ML)**
					180		Hard, intercollated blAck to brown silty clay with laminar bands oF organics/wood/plant. **EOC**.

Coring Contractor	Marine Sampling Systems/RV Nancy Ann
Coring Method	Vibracore
Core Type	4" OD; 3.75"ID pre-cleaned 6061 Aluminum
Core Collected	20-April-2008 10:24
COORDINATES	
SURFACE ELEVATION	
DATUM	

Notes:
Penetration: 19 ft
Acquisition: 16.4 ft
Recovery: 86%

Core not expanded based on compaction during processing
Material in core catcher discarded.

BORING NUMBER	SDDC-24
PROJECT	U.S. Moorings
LOCATION	Willamette River, Portland, OR
PROJECT NUMBER	
DATE	21-Apr-08
LOGGED BY	D. Browning

SAMPLE INFORMATION						STRATA	DESCRIPTION
Sample ID	Time	No. of Jars	% Recov.	Sheen	Depth (inches)		USCS group name, color, grain size range, minor constituents, plasticity, odor, sheen, moisture content, texture, weathering, cementation, geologic interpretation, etc.
				N			**0-10" SILTY CLAY (ML)**
				N			Loose, wet, unconsolidated, slightly silty clay (30/70) with slight natural organic odor.
				N	12		**10"-60" SILTY CLAY (ML)**
				N			Soft, moist to wet, organic, silty clay (30/70) with methane vesicles and becomes slightly
				N	24		firmer with increasing depth.
				N			
				N	36		
				N			
				N			
				N	48		
				N			
				N			
				N	60		
				N			**60-126" SILTY CLAY (ML)**
				N			Layered silty clay (30/70) with black banding at 76" that has strong coal tar odor.
				SS	72		
				SS			
				SS			
				SS	84		
				SS			Wood lens.
				MS	96		**96-114" SILTY CLAY (ML)**
				MS			Loose, wet, black, woody silt with H2S and Coal tar odors. Strong. Sheen in abundant 0.2 "
				MS	108		florets.
							114-120" - Not logged. Retained intact for geotech sample
					120		
				MS			124" Void in core that extended into geotech sample.
				MS			**126-144" SILTY CLAY (ML)**
				MS	132		Laminated, black, organic silty clay with wood fragments, sheen and strong PAH odor.
				MS			Several laminar bands have mineralized PAH parting planes.
					144		**EOC**
					156		
					168		
					180		

Coring Contractor	Marine Sampling Systems/RV Nancy Ann
Coring Method	Vibracore
Core Type	4" OD; 3.75"ID pre-cleaned 6061 Aluminum
Core Collected	19-April-2008 14:12
COORDINATES	
SURFACE ELEVATION	
DATUM	

Notes:
Penetration: 15 ft
Acquisition: 13 ft
Recovery: 87%

Core expanded based on compaction during processing
Material in core catcher discarded.

Attachment 4

Summary of Bulk Chemical Characteristics in Subsurface Sediment Cores

Attachment 4. Summary of the bulk chemical characteristics in subsurface cores

Field ID	Core Depth	TPAH (µg/Kg)	LPAH (µg/Kg)	HPAH (µg/Kg)	Σ Biomarkers (µg/Kg)	TPH (mg/Kg)	Core Descriptions
A-52-BA-0	0" - 2"	5,050	1,370	3,680	418	485	
A-52-BA-18	18" - 20"	10,200	2,730	7,470	776	466	115-118 cm. **1 cm bleb of in-situ sheen at top of unit** and is associated with wood fragment.
A-52-BA-28	28" - 30"	36,000	15,900	20,100	1,100	631	
A-52-BA-54	54" - 56"	12,800	3,840	8,950	2,580	953	
B-43-BB-0	0" - 2"	20,200	8,320	11,800	435	379	99-112 cm. in situ sheen at 110.5 cm, **moderate coal brown NAPL and ropy sheen can be floated** out with application of water. t**ar odor and small (1-2mm) blebs of brown NAPL and ropy sheen can be floated out with application of water.** 112-189 cm, preserved methane vesicles. Slight coal tar odor and natural organic odor. 170-179 cm florets of sheen can be produced by streaking sediment and sheen can prodiced from this usit with application of water. **189-214 cm - strong coal tar odor and 1-3 cm streak of in situ dull sheen**.
B-43-BB-24	24' - 26"	13,400	3,190	10,200	848	615	
B-43-BB-40	40" - 42"	356,000	201,000	154,000	708	1,000	
B-43-BB-78	78" - 80"	1,850,000	901,000	953,000	9,090	7,080	
C-42-BC-0	0" - 2"	17,500	4,510	13,000	315	330	153-172 cm slight PAH odor and **thin ropy blue sheen** can be produced with application of water, otherwise no sheen elsewhere. 172-221 cm - **strong coal tar odor. 1-2 mm blebs of product and stringer, sheen** with application of water. 276-276.5, 287-291, 325-328, and 358-362 cm. **black laminar bands** of compositinally identical sediment with moderate strong coal tar odor. **Strong odor a**t 358-362 cm unit. **Sheen** can be produced with application of water in these units.
C-42-BC-24	24' - 26"	29,200	7,490	21,700	2,050	774	
C-42-BC-82	82"- 84"	280,000	160,000	120,000	3,170	1,840	
C-42-BC-114	114" - 116"	185,000	94,900	90,200	6,730	2,570	
D2-53-BD-0	0" - 2"	7,040	2,050	4,990	423	488	
D2-53-BD-24	24' - 26"	584,000	190,000	394,000	786	1,460	58 cm - vesticulated slag with PAH odor. 71 cm - Coal tar odor. 125 cm - 1 mm stringer of sand, coal tar odor. 195-199 cm - distinct coal tar odor, 205-212 cm - **strong coal tar odor**, **sheen** can be produced as ribbons with application of water. 295 cm - **laminar band of black sediment with strong coal tar odar**, **sheen** produced with application of water. 357-363 cm B**lack strained band of sedimen**t w**ith strong coal tar odor** and **sheen** can be produced in-situ with application of pressure.
D2-53-BD-83	83" - 85"	378,000	235,000	142,000	1,200	1,410	
D2-53-BD-118	118"- 120"	189,000	117,000	72,000	821	907	
E-40-BE-0	0" - 2"	121,000	33,000	88,100	871	680	109-139 cm - **strong coal tar odor. Blue strings of sheen** produced with application of water. 139-193 cm - Clay clasts have st**rong coal tar odor** and **ropy blue sheen ca**n be proudced with application of water.
E-40-BE-24	24' - 26"	97,700	27,900	69,700	2,520	1,130	
E-40-BE-52	52" - 54"	225,000	87,900	137,000	1,540	1,290	

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Attachment 4. Summary of the bulk chemical characteristics in subsurface cores

Field ID	Core Depth	TPAH (µg/Kg)	LPAH (µg/Kg)	HPAH (µg/Kg)	Σ Biomarkers (µg/Kg)	TPH (mg/Kg)	Core Descriptions
F-SS20-BF-0	0" - 2"	26,200	5,760	20,500	477	572	184-228 cm - slight coal tar odor. 228-373 cm - slight coal tar odor, **black laminar bands** at 225-228 cm with **moderate to strong coal tar odor.** 244-245 cm with **strong coal tar odor.** 267-269, 288-295 cm , 315-315.5 cm, 319-320 cm **strong coal tar odor and blue ropy sheen** produced with appliation of water. In **black layers, sheen** can also be produced in sit with applicatin of pressure. 333-341 cm **slight vanillin odor** in addition to **strong coal tar odor.** 366-373 cm s**trong coal tar odor and blue ropy sheen** produced with applicaiton of water.
F-SS20-BF-24	24' - 26"	19,600	7,630	12,000	542	307	
F-SS20-BF-116	116" - 118"	1,060,000	719,000	336,000	5,290	4,860	
F-SS20-BF-146	146" - 148"	235,000	115,000	120,000	6,090	2,320	
G-50-BG-0	0" - 2"	36,100	17,700	18,400	781	337	
G-50-BG-26	26" - 28"	2,110,000	944,000	1,170,000	859	4,080	44-104 cm - **wood particles a**re mechanically fragmented and many have **blue coating that becomes more pronounced with increased time exposed to air. Strong tar ordor.** Minor sheen with water. 104-427 cm - **numerous dopositional bands** in unit. 136-136.5 wood/plant fragements with **coal tar odor,** 140-142.2 cm **black stained sediment band in laminar orientation. NAPL.** 161-170 cm **black woody strong coal tar odor.** 191-192 cm **black stained sediment and mineralized NAPL plane. Very strong coal tar odor.** 213-227 cm - b**lack organic in-situ sheen and strong oal tar and napthalene odors.** 233-240 cm - v**ery strong napthalene odor. NAPL and blue sheen with application of water.** 245-256 cm - **strong to overwhelming napthalene odor. In situ sheen with pressur**e. 256-261 cm. **In situ sheen , mineralized NAPL bands, very strong napthalene odor. NAPL.** 261-299 cm **Black dense in situ sheen. Very strong coal tar odor.** 299-315 cm - **very strong coal tar and napthalene odor.** 315-317- cm - **black strong in insitu sheen and NAPL. Very strong coal tar and napthalene odor.** 317-350 cm - **strong coal tar odor**. 352-367 cm - **in situ sheen and very stron coal tar odor.** 367-374 cm - **black in situ sheen - strong coal tar odor.** 380 **Plane of mineralized NAPL.** 390-391 cm - **laminar black band with in-situ sheen and very strong coal tar odor.** 391-427 cm moderate coal tar odor.
G-50-BG-72	72" - 74"	409,000	257,000	151,000	922	1,110	
G-50-BG-98	98" - 100"	1,830,000	1,170,000	653,000	2,910	3,660	
G-50-BG-116	116" - 118"	5,870,000	2,720,000	3,150,000	7,040	13,000	
G-50-BG-146	146" - 148"	3,860,000	1,950,000	1,910,000	14,800	12,100	
SDUD-1-1	0" - 12"	298,000	69,500	228,000	481	1,140	
SDUD-1-2	12" - 24"	98,700	36,400	62,300	276	338	
SDUD-2-1	0" - 12"	158,000	37,100	122,000	525	700	
SDUD-27-1	0" - 12"	148,000	35,200	113,000	452	812	
SDUD-27-2	12" - 24"	464,000	176,000	289,000	1,910	1,470	

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Field ID	Core Depth	TPAH (µg/Kg)	LPAH (µg/Kg)	HPAH (µg/Kg)	Σ Biomarkers (µg/Kg)	TPH (mg/Kg)	Core Descriptions
SDDA-18-28	28" - 30"	527,000	345,000	182,000	2,910	2,570	1-10" - **Petrouleum odor**. 10-10.75 " **black band with strong petroleum odor and sheen. Mineralized parting plane**. 10-75-48" **Bands of black sediment throughout unit and banded sediment has strong PAH odor.** 40-90" - **Bands of black sediment that has strong PAH odor and sheen. Mineralized PAH parting plane in 63" band.** 96-109" - **mineralized PAH parting planes** at 102 and 107".
SDDA-18-58	58" - 60"	634,000	366,000	267,000	7,300	4,290	
SDDA-18-106	106" - 108"	3,110,000	1,750,000	1,370,000	7,470	9,600	
SDDA-19-58	58"-60"	302,000	145,000	156,000	8,560	3,880	20-29" **PAH odor.** 20-48" b**ands of black clay with moderate to strong PAH odor** at 38", 42 and 46". 48-100" - b**anded with black bands with strong coal tar odor and slight sheening.** With **mineralized PAH parting planes**.
SDDA-19-72	72" - 74"	428,000	208,000	220,000	3,590	2,510	
SDDB-20-3	24" - 36"	80,900	30,400	50,500	1,320	920	1-74" - Methane vesicles. 74-82" - **PAH odor with black bands**. 82-144" - **black bands that have diffuse sheen and strong PAH odor**.
SDDB-20-4	36" - 48"	231,000	149,000	81,700	2,680	1,530	
SDDB-20-111	111" - 113"	324,000	192,000	132,000	4,270	2,320	
SDDB-20-129	129" - 130"	538,000	313,000	225,000	6,290	3,380	
SDDB-21-132	132" - 134	71,100	32,800	38,300	2,470	1,280	10-48, 54-118" - methane vesicles. 118-144" - scattered minor black sediment and **PAH odor**.
SDDB-22-3	24" - 36"	224,000	83,000	141,000	2,940	1,550	10-60" methane vesicles. 33" **thin black band** and slight PAH odor., 42" **black band.** 66-96" **darkest patches of sediment have PAH odor**.
SDDC-23-3	24" - 36"	562,000	443,000	120,000	3,430	2,720	10-22" - methane vesicles and slight PAH odor. 22-48" - **black bands** . 48-120" t**hin laminar bands of organic**s. 72-84" - black organic inclusion that contain wood fragments and have **PAH odor**. 108-120" - **Sediment becomes darker sheening occurs and strong PAH odor**. 120-144" - Banded black and brown silty clay with laminar leanses of wood particles. V**ery strong PAH/coal tar odor**. No free NAPL but **widespread inesesent sheen in 0.1-0.25 florets**. 162 - 163 - each band is 0.2 " thick and has a **strong sheening and strong to overwheming PAH .Coal tar odor.** 171-180" t**hick band of black, PAH enriched sediment with strong odor.** 180-192" laminar bands of organic/wood/plant.
SDDC-23-4	36" - 48"	228,000	109,000	118,000	4,570	1,900	
SDDC-24							10-60" - methane vesicles. 60-126" - **black banding** at 76" that has **strong coal tar odor**. 96-114" - black, woody silt with H2S and **coal tar odors**. **Strong sheen.** 126-144" - laminated balck organic silty clay with wood fragment**s sheen and strong PAH odor**. Se**veral laminar bands have mineralized PAH parting planes.**

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Field ID	Core Depth	TPAH (µg/Kg)	LPAH (µg/Kg)	HPAH (µg/Kg)	Σ Biomarkers (µg/Kg)	TPH (mg/Kg)	Core Descriptions
SDDC-25-1	0" - 12"	1,460,000	400,000	1,060,000	1,890	3,730	Core 2. 0-24" - **PAH odor.** 24-48" - methane vesicles an d layer has **strong PAH odor**. 58-61" - strong H2S odor and slight PAH odor. 64" -**Bands of black, PAH enriched sediments with mineralized PAH plane**. 78-87" H2S and **PAH odors** with wood fragments.
SDOF-28							5-48" slight limey/calcic odor. Methane vesicles. 48-96" - methane vesicles. 96-112" - methane vesicles, 0.5" t**hick black layers that have sheen and strong PAH odor**.

Notes:

Highlight indicates sediment core with substantial product.

Bold in core description indicates observation associated with product

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